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THESIS

**THE FORGOTTEN DISASTER VICTIM: REDUCING
RESPONDER INJURY**

by

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March 2017

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THE FORGOTTEN DISASTER VICTIM: REDUCING RESPONDER INJURY

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ABSTRACT

First responders, including firefighters, police officers, emergency medical service workers, and disaster clean-up teams, are often the forgotten victims of disaster response and recovery, suffering higher injury and illness rates than other population groups. Hampered by limited data collection from past disasters and few existing disaster response injury studies, this thesis examined disaster response case studies to illuminate responder injury and illness issues. Recommendations to reduce injuries and improve responder safety include better training before a disaster, proper use of personnel protective equipment, and strict enforcement of existing policies, rules, and laws at the scene of a disaster.

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LIST OF ACRONYMS AND ABBREVIATIONS

BLS	Bureau of Labor Statistics
CDC	Centers for Disease Control and Prevention
CFOI	Census of Fatal Occupational Injuries
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
GAO	Government Accountability Office
OCFD	Oklahoma City Fire Department
OSHA	Occupational Safety and Health Administration
PPE	personal protective equipment
SOII	Survey of Occupational Injuries and Illnesses
USACE	United States Army Corps of Engineers
USAR	Urban Search and Rescue Teams
WTC	World Trade Center

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EXECUTIVE SUMMARY

This thesis analyzed rates of injury among disaster responders, and examined how laws, rules, and procedures facilitate responder safety during disaster response. Disaster responders are not only the traditional first responders, such as fire, police, and EMS, but also include incident management and skilled support personnel such as ironworkers, operating engineers, laborers, cleanup workers, and volunteers.

Results of data analyzed show that injury rates for disaster responders are elevated when compared to national averages, as well as when compared to injury rates for first responders in general. The research finds considerable room both for additional research on injury and illness rates in disaster response and improvement in oversight and enforcement of safety standards. Recommendations discussed include:

- improved data collection of injury rates in disaster responses
- enforcement of existing safety policies
- improved risk surveillance
- ensured adequate staffing
- improved training for skilled support personnel

This thesis research was limited by poor record keeping during disasters, fragmentation of existing data across different levels of government, and limited existing studies into the area.

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I. INTRODUCTION

This thesis examines the safety of responders during a disaster response. When posing questions about responder safety in disasters, it is important to illuminate what is included in the realm of responders as well as disasters. The Federal Emergency Management Agency (FEMA) identifies a disaster as “an event that exceeds the capacity of the affected area to respond to it in such a way as to save lives; to preserve property; and to maintain the social, ecological, economic, and political stability of the affected region.”¹

In post-disaster situations, responders are not only the traditional first responders, such as fire, police, and emergency medical service, but also include incident management and skilled support personnel such as ironworkers, operating engineers, laborers, cleanup workers, and volunteers.² For this investigation, the concept of “safety” includes physical injury, illness, and disease to responders that result from participation in a disaster response.

The health of responders is a critical part of disaster response. In addition to meeting legal requirements, ensuring the health and safety of responders minimizes costs incurred due to injury and allows responders to physically perform their assigned duties. Studies of past disasters indicate a pattern of illness and injury among responders. Similar physical injuries and health issues are present among responders to September 11, Hurricane Katrina, Hurricane Sandy, and other disasters.³ The intent of this research is to analyze injury and safety in past responses (and the effects they have on responders); determine what, if any, common threads exist; and propose recommendations for action.

¹ FEMA, “Theory, Principles, and Fundamentals of Hazards, Disasters, and U.S. Emergency Management: Defining Disaster,” Emergency Management Institute course, accessed February 10, 2017. <https://training.fema.gov/hiedu/aemrc/courses/coursesunderdev/hazdisusems.aspx>.

² Joy C. Lee Pearson and Deborah Weinstock, “Minimizing Safety and Health Impacts at Disaster Sites: The Need for Comprehensive Worker Safety and Health Training Based on an Analysis of National Disasters in the U.S,” *Journal of Homeland Security & Emergency Management* 8, no. 1 (2011): 1–16.

³ Ibid.

A. RESEARCH QUESTION

The primary research question is: How can laws, rules and procedures facilitate responder safety during disaster response?

B. RESEARCH DESIGN: MULTI-GOAL ANALYSIS

There are already numerous existing policies for responder safety both generally, and specifically in disasters. A policy analysis focuses on understanding the current policy. It involves in-depth analysis of existing policies, identifying their strengths and weakness, and results in recommendations for changes. Occupational Safety and Health Administration (OSHA) rules and regulations make up the framework of the existing general policy while the Federal Emergency Management Agency's (FEMA's) Worker Safety and Health Support Annex to the National Response Framework forms the base for safety policy specifically in disasters. In addition to these federal policies, there are numerous industry, local, and state laws, regulations, and policies. However, given the high number of agencies with responder responsibilities, the majority of local policies are not reviewed nor considered in this thesis; instead, the national policies are of primary concern.

To better quantify the problem and measure possible solutions, a quantitative analysis of existing injury and illness rates provides an ideal baseline for effective analysis. Coupled with the policy analysis, a multi-goal analysis of policy effectiveness will help to identify gaps or problems with existing implementation of safety policies.

1. Limitations and Scope

This research faced several limitations. While it is the intent of this analysis to help eliminate injury and illness among responders, attaining an injury-free workplace in any work environment is nearly impossible; so, instead, this thesis focuses on reducing the rates of injury or illness. Additionally, limited information is available, especially in light of poor record-keeping and the infrequency of events that garner widespread deployment of resources to disasters. As a result, it is not possible to include a broad scope of disaster events; instead, the focus is on the most impactful events.

The scope of this thesis is limited to physical illnesses and injuries. While mental health is important to the overall health of responders, including mental health issues as part of this analysis would drastically broaden the scope. Additionally, mental health issues often cannot be tied to a particular event and may not present until later in life, making it difficult to target the specific cause. Furthermore, there is much existing literature on mental health issues. This thesis focuses, instead, on physical injuries, for which the cause and correlation can be clearly established, and for which there is a greater need for further research.

The review focuses on responder safety in the United States. Aggregate data from presidential disaster declarations reveals that, in general, the most impactful disasters, as measured by their cost, are man-made disasters, severe storms, hurricanes, floods, and earthquakes.⁴ Additionally, in selecting events for analysis, the availability of injury and illness data must also be considered. Resultantly, the events of primary concern are the Oklahoma City Bombing, September 11, Hurricane Katrina, and Deepwater Horizon.

2. Data Sources

There is a substantial amount of material about the effects of disasters on responders, as well as on the need to provide better resources and care for responders, especially surrounding the events of September 11, Hurricane Katrina, and many other post-September 11 events. For the events of September 11, especially, there has been systematic tracking and follow-up with responders through organizations such as the World Trade Center (WTC) Health Registry, which provides a high level of detailed data and analysis on the health of responders. To identify breakdowns in the safety systems, after action reviews from various events proved to be invaluable.

⁴ Gregory van der Vink et al., “The Increasing Costs of U.S. Natural Disasters,” *Geotimes* (November, 2005), 25.

3. Mode of Analysis

The mode of analysis used in this thesis, described in this section, is adapted from Eugene Bardach's *A Practical Guide for Policy Analysis*.⁵

(1) Step 1: Defining the Problem

The first step is to clearly identify that there is a problem. This is accomplished by a quantitative analysis of existing injury and illness rates based on previous research and injury data collected from various sources, including Government Accountability Office (GAO) reports, occupational injury data, and published medical research.

Step 1A: General Injury Rates: In order to perform a quantitative analysis, there must be a baseline for comparison of the data. To form this baseline, the workplace injury and illness statistics maintained by the U.S. Department of Labor for general employment in the United States are used. This analysis allows injury rates to be compared to the average injury rate for American workers.

Step 1B: Disaster Case Studies: During the course of research, it was determined that there was no single consolidated set of data with which to quantify responder injuries and illness in disasters. Instead, the data was segmented, primarily by event and often by occupation as well. Several specific disasters were selected based on the amount of data available and the impact of the events. These events are analyzed and the injury and illness rate quantified in a comparable format to the general injury rates.

(2) Step 2: Establishing Goals

Once the prevalence of injuries is established, based on the injury rates discovered in step one, an in-depth analysis of existing research is needed. If the existing rules are intended to prevent common injuries, what caused the rules to fail? How can policy improve the safety of responders during a disaster response, and what is an appropriate goal for reduction?

⁵ Eugene Bardach, *A Practical Guide for Policy Analysis*, fourth ed. (Thousand Oaks, CA: CQ Press, 2012).

(3) Step 3: Selecting a Policy

Once policy gaps have been identified, an analysis of those gaps determines what measures can be taken to prevent injuries in the future (either by adjusting the implementation of existing rules or by recommending new ones). This analysis examines possible barriers to implementation such as cost and practicality, as well as any impact of a hindrance on the response operations. These recommendations come from existing unimplemented recommendations, best practices, and developing research.

(4) Step 4: Valuing and Evaluating the Suggested Policy

Once a policy adjustment has been determined, the likely effects of the modification must also be determined, if possible. Comparisons of implementation in pilot programs, limited events, and other fields are used as a baseline to determine the effects. Those results are then compared against the goals to determine the best policy alternative.

4. Output

This research culminates with a set of recommendations for improving the safety of responders based on new or enhanced applications of existing procedures, or modification of existing policies.

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II. LITERATURE REVIEW

The information included in this literature review was collected from research conducted between September 2014 and February 2016. The research was primarily conducted through research databases provided by the Naval Postgraduate School's Dudley Knox Library, including databases such as EBSCO, JSTOR, ProQuest, and WorldCat. Searches were conducted using a series of systematic keywords designed to catch a wide breadth of material. Some additional information was also collected from wider searches using Google Scholar, as well as referrals to material provided by colleagues.

The purpose of this review is to summarize the existing literature on responder safety in disasters, identify gaps in the information, and identify areas that require further inquiry and research. An initial overview of the sources indicates numerous gaps in available data. While there is substantial written material about health-related disaster effects on responders surrounding the events of September 11, there is very little related literature predating 2001. Additionally, much of the research identifies areas of concern but fails to outline clear recommendations or solutions. Consequently, there remains substantial room for additional research and inquiry on the subject.

A. LEGAL REQUIREMENTS

OSHA has published various standards that apply to disaster response.⁶ Even a simple list of these standards would occupy several pages. The requirements cover everything from workplace safety features, to safeguards required for specific tasks (such as firefighting, iron working, debris removal, etc.), to standard protection equipment for responders.

OSHA standards require training for covered employees. Generally speaking, for responders, this includes hazard communication, respiratory protection, personal protective equipment, blood-borne pathogens, and hazardous waste operations and

⁶ Occupational Safety and Health Standards, 29 C.F.R. § 1910.

emergency response.⁷ However, research conducted by Pearson and Weinstock in 2011 indicated that this training is often not provided to skilled support personnel, as they do not fall into the first responder category.⁸ Pearson and Weinstock also explain that provision of training and equipment before a disaster event has been identified numerous times as paramount to workers' ability to efficiently and safely respond to disasters.⁹ The GAO has found that responders proceeding with missing or incomplete equipment are more likely to suffer from injuries or illness that will prevent them from continuing to perform their duties.¹⁰ Proper equipment is paramount to responders and has been identified as a needed action since at least the WTC response.

However, GAO reports also show that, while these standards are critical to providing protection to workers, OSHA has temporarily suspended enforcement following many recent disasters in heavily impacted areas with the goal of expediting recovery.¹¹ OSHA continues to make this decision so as not to hamper rescue efforts, instead providing technical assistance to responders in lieu of formal enforcement action.¹²

B. DISASTER DATA

Data sources for specific disasters are infrequently available and difficult to locate. As a result, the events chosen for analysis are based primarily on the availability of data. These events tended to be the most familiar ones, and were likely widely researched due to the extensive public attention they received at the time.

⁷ Occupational Safety and Health Administration (OSHA), *Principal Emergency Response and Preparedness Requirements and Guidance* (OSHA 3122-06R) (Washington, DC: U.S. Department of Labor, 2004), <http://www.osha.gov/Publications/osha3122.pdf>.

⁸ Pearson and Weinstock, "Minimizing Safety and Health Impacts at Disaster Sites."

⁹ Ibid.

¹⁰ Cynthia Bascetta, *September 11: HHS Needs to Ensure the Availability of Health Screening and Monitoring for all Responders* (GAO-07-892) (Washington, DC: Government Accountability Office, 2007).

¹¹ Katherine Torres, "Legislators Question Enforcement Suspension after Disasters," EHS Today, July 7, 2006, http://ehstoday.com/news/ehs_imp_38319.

¹² Government Accountability Office (GAO), *Disaster Preparedness: Better Planning would Improve OSHA's Efforts to Protect Workers' Safety and Health in Disasters* (GAO-07-193) (Washington, DC: Government Accountability Office, 2007).

One of the earliest studies into the impact of disasters on responders is for the Oklahoma City bombing. The event had substantial interest at the time, including some interest among the medical community; a study on responder safety was subsequently published in the *American Journal of Industrial Medicine*.¹³ The study revealed systematic poor tracking of injuries by responders as well as a number of injuries that could have been prevented with proper training or personal protection equipment.¹⁴

The most extensive amount of literature about responder safety surrounds the events of the WTC tragedy. In the aftermath of September 11, 2001, disaster response workers reported a broad range of injuries and illnesses, from minor sprains to acute respiratory and mental health illnesses.¹⁵ The most prevalent and sustained illness among the estimated 60,000 to 70,000 responders was respiratory illness, with at least 6,500 responders suffering from significant or worsened respiratory symptoms.¹⁶ Numerous organizations have been set up to provide medical surveillance of the WTC responders over the long term. The largest of those is the World Trade Center Worker and Volunteer Medical Screening Program, which has 7,810 participants.¹⁷ The literature surrounding this surveillance is substantial; it has played a prominent role in revisions to responder safety guidance for disasters, especially as it relates to the provision of personal protective equipment.¹⁸

Due to the extensive effects of Hurricane Katrina (and Hurricane Rita, which impacted the Atlantic two weeks later and is often grouped with Katrina), there was substantial interest in the event. As a result, there are a number of sources of information, from GAO reports to independent research.

¹³ Ann M. Dellinger, Richard J. Waxweiler, and Sue Mallonee, "Injuries to Rescue Workers Following the Oklahoma City Bombing," *American Journal of Industrial Medicine* 31, no. 6 (1997): 727–732.

¹⁴ Ibid.

¹⁵ Pearson and Weinstock, "Minimizing Safety and Health Impacts at Disaster Sites."

¹⁶ Bob Weinhold, "Emergency Responder Health: What have we Learned from Past Disasters?" *Environmental Health Perspectives* 118, no. 8 (2010): 348.

¹⁷ K. R. Perritt et al., "Work-Related Injuries and Illnesses Reported by World Trade Center Response Workers and Volunteers," *Prehospital and Disaster Medicine* 26, no. 06 (March, 2012): 401–407, doi: 10.1017/S1049023X12000143.

¹⁸ GAO, *Disaster Preparedness*.

During the Deepwater Horizon Gulf oil spill, substantial attention was paid to medical surveillance of the responders. The most common injuries during the response were lacerations, sprains, and contusions; however, the long-term health effects are still unclear.¹⁹ Since the end of the response, the National Institute of Environmental Health Sciences has made a concerted effort to monitor response workers. However, the initial results of the medical surveillance will not be available until at least 2018.

There has also been significant interest in the occupational health impacts of responders following Hurricane Sandy. Because much of that analysis is still ongoing, however, the data has not yet been published.²⁰ Available data can be found in investigatory reports from local news agencies and some limited government reporting.

C. GENERAL INJURY RATES

The Bureau of Labor Statistics (BLS) compiles an annual report on workplace injuries, illnesses, and fatalities. This report includes a breakdown of injury rates by industry, occupation, and geographic location, as well as some analysis of unusually high rates or large numbers of injuries within certain occupations.²¹ The analysis includes an additional breakdown by the cause and source of the injury if it involves one or more days away from work.²² This data plays a fundamental role in establishing an average national injury rate for occupations, and is analyzed in depth in Chapter III: Injury Rates. However, BLS statistics do not go into event-specific details.

Additional research has also been conducted to expand upon BLS statistics in specific occupational areas. Emergency responders (generally defined as first responders) have been an area of curiosity and several reports analyze surveillance data on injury

¹⁹ “NIOSH Report of Deepwater Horizon Response/BP Illness and Injury Data (April 23 – July 8, 2010),” Centers for Disease Control and Prevention (CDC), July 27, 2010, 8, <https://www.cdc.gov/niosh/topics/oilspillresponse/pdfs/NIOSHrot-BPillnessAndInjuryDataApril23-July8-2010.pdf>.

²⁰ Michael J. Reilly, “Impact of Health Department Worker Safety Training on Health Impacts after Sandy,” National Institutes of Health, August 10, 2015, <http://grantome.com/grant/NIH/U01-OH010625-01S1>.

²¹ “Injuries, Illnesses, and Fatalities,” Bureau of Labor Statistics, accessed January 12, 2016, <http://www.bls.gov/iif/>.

²² Ibid.

rates among first responders in general. RAND produced an extremely detailed analysis in 2004 on emergency responder injuries and fatalities, which found that the fatality rate for both police and firefighters was approximately three times that of the general population.²³ This research aligns with other studies, including a 2010 study published in the *American Journal of Industrial Medicine*.²⁴

Overall, there is little data on physical injuries to responders, most of the research is scattered, and there is little consolidated research on the matter. There have been only a few controlled studies conducted on disaster responder populations, with much of the existing research gleaned from reports and analyses conducted after the events.²⁵ As a result, most research sources agree that disaster responders are “faced with poorly characterized risk and unknown short and long-term health consequences.”²⁶

²³ Ari Houser et al., *Emergency Responder Injuries and Fatalities* (Santa Monica, CA: RAND, 2004), xv.

²⁴ Audrey A. Reichard and Larry L. Jackson, “Occupational Injuries among Emergency Responders,” *American Journal of Industrial Medicine* 53, no. 1 (2010): 1–11.

²⁵ Jennifer A. Rusiecki et al., “Disaster-Related Exposures and Health Effects among U.S. Coast Guard Responders to Hurricanes Katrina and Rita A Cross-Sectional Study,” *Journal of Occupational and Environmental Medicine* 56, no. 8 (August 2014): 828, doi:10.1097/JOM.000000000000188.

²⁶ Ibid., 829; Heidi Swygard and Renae E. Stafford, “Effects on Health of Volunteers Deployed during a Disaster,” *The American Surgeon* 75, no. 9 (September, 2009): 747.

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III. INJURY RATES

To determine if disaster responders face an increased risk of illness, there must first be a baseline for comparison. Three sets of data have been analyzed to provide a comparison: injury rates among the general working population; injury rates among traditional first responders (fire, police, and paramedics) in their normal roles; and injury rates among disaster responders.

The main sources of the base data come from three different types of sources that provide data on occupational hazards, injuries, and illnesses faced by responders: occupation-specific sources, event-specific sources, and general population data.

- Occupation-specific sources are limited to a particular subset of one occupation or group of related occupations. The collected data focuses on the specific issues and hazards facing that specific occupation; as a result, the data can be highly detailed and formatted to address a particular concern.
- Event-specific sources are collected as the result of a particular event. The data requirements and scope of the collection varies, but generally will cover the subset of occupations participating in the incident.
- General population data provides standardized data in a common format, but only breaks reporting down by occupation and not by participation in a particular event. So, while useful in determining a baseline for comparison, it cannot provide injury rates of those participating in a given event.

Various government and non-government organizations track injuries and fatalities; the level and detail of this tracking varies between sources. To provide a standard for comparison, these statistics have been summarized into specific categories of injury. To account for varying datasets and differing sample sizes, this analysis uses the incidence rate as the basis for comparison. The incidence rate is the primary statistic utilized by the BLS for comparison of injury rates across industries. It is defined as the annualized number of injuries per 100 workers.²⁷ Furthermore, since data collected from different sources will have a range of reporting periods, every effort is made to compare

²⁷ “Injuries, Illnesses, and Fatalities.” Bureau of Labor Statistics.

rate between similar reporting periods, and any discrepancies between timeframes are noted.

Additionally, there are a number of studies based either directly on collected injury data, or that examine specific occurrences of injuries in disasters. Several of these studies examined the effectiveness of safety measures and policies, and reviewed compliance rates with policies, including identifying why employees failed to comply; these studies provide important insight into injury rates and are thus incorporated into the discussion.

A. INJURY RATES AMONG THE GENERAL POPULATION

The primary data source available for injury rates among the general population comes from the Survey of Occupational Injuries and Illnesses (SOII) and the Census of Fatal Occupational Injuries (CFOI) collected by the BLS and published each year.²⁸ The SOII is the most comprehensive catalog of occupational injuries and illness in the United States. It provides information on work-related injuries, illnesses, and the rate at which they occur for a broad range of industries, employees, and injury types. The SOII covers a sample of over 230,000 private industry establishments as well as select state and local governments. Due to statutory jurisdictional limits imposed on OSHA, self-employed individuals, federal government employees, and employees of the United States Postal Services are excluded from the SOII data.²⁹ The CFOI is an extensive catalog of fatal workplace injuries in the United States covering private industry and local, state, and federal government employees. The BLS uses multiple sources to verify each fatal injury and determine if it is a work-related nexus, and to collect information on the cause and circumstances of the injury and the employee's characteristics.³⁰

²⁸ Ibid.

²⁹ "Survey of Occupational Injuries and Illnesses," CDC, accessed January 12, 2016, <http://wwwn.cdc.gov/niosh-survapps/gateway/Database.aspx?id=28>; Ryan Sutter and Kristina Schafer, *Characteristics of Individuals and Employment among First Responders* (Washington, DC: U.S. Department of Labor, 2015).

³⁰ "Census of Fatal Occupational Injuries (CFOI)," Bureau of Labor Statistics, accessed January 12, 2016, <http://www.bls.gov/iif/oshfat1.htm>.

The SOII data for 2014, the most recent year for which it was available, represented 3.0 million nonfatal workplace injuries and illnesses, with an incidence rate of 3.2 cases per 100 workers.³¹ Furthermore, the data collected over the past ten years (shown in Figure 1) demonstrates a general trend of decreasing injury rates among employees, with the average incidence rate decreasing from 4.8 in 2004 to 3.2 in 2014.³²

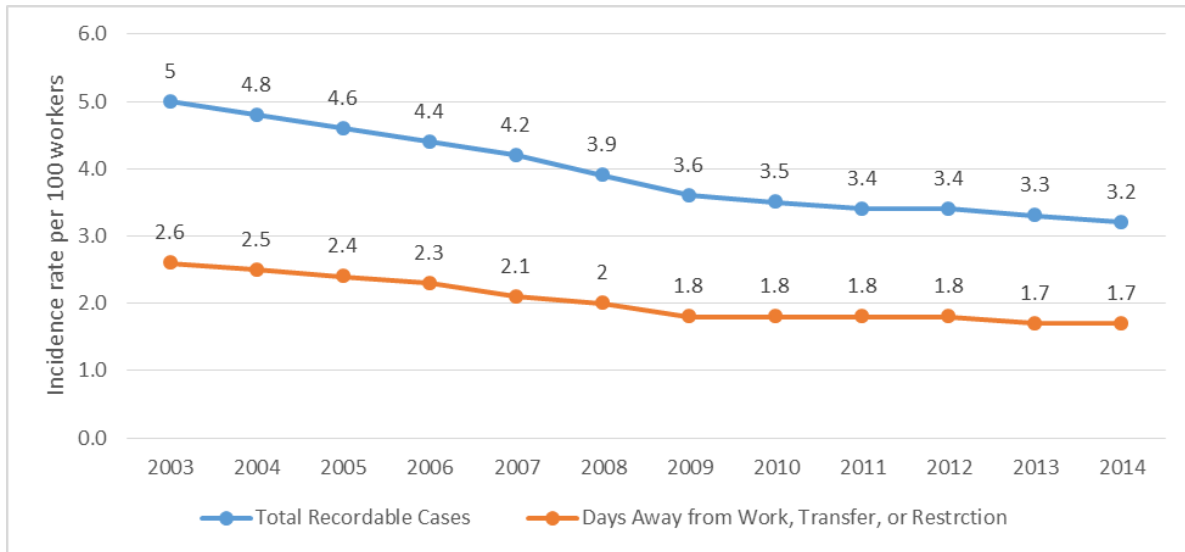


Figure 1. Nonfatal Occupational Injury and Illness Incidence Rates by Case Type, 2003–2014³³

These rates are similar across most industries; however, there is a noticeably higher rate among state and local governments (see Table 1), with approximately 47 percent more injuries than the general population.³⁴

³¹ Ibid.

³² Bureau of Labor Statistics, *Employer-Reported Workplace Injuries and Illnesses—2014* (Washington, DC: U.S. Department of Labor, 2015).

³³ Adapted from Bureau of Labor Statistics, *Employer-Reported Workplace Injuries and Illnesses*, Chart 1.

³⁴ Bureau of Labor Statistics, *Employer-Reported Workplace Injuries and Illnesses*.

Table 1. Incidence Rates of Nonfatal Occupational Injuries, 2014³⁵

Industry		Total Recordable Cases	Cases with Days away from Work, Transfer, or Restriction
All Industries		3.4	1.8
	Private Industry	3.2	1.7
	Goods-Producing	3.8	2.2
	Construction	3.6	2.0
	Manufacturing	4.0	2.2
	Service-Providing	3.0	1.6
	Education and Health Services	4.2	2.0
	State and Local Government	5.0	2.3

Incidence rates of nonfatal occupational injuries by select North American Industry Classification System (NAICS) sectors.

B. INJURY RATES AMONG FIRST RESPONDERS

Although the focus of this thesis is on the larger disaster responder community, the first responder daily workplace represents the closest comparison to the conditions experienced by disaster responders, with first responders experiencing a variable and strong hazard environment in their day-to-day work activities.³⁶ Past studies have indicated that the physical demands of response may be the leading cause of injuries among first responders, and as such it is prudent to compare injury rates among disaster responders to not only the general population but also to this subset of the general population with similar occupational demands.³⁷

Several past studies have focused on occupational injuries among first responders, which includes police, firefighters, and emergency medical technicians (EMTs).³⁸ These studies have found that both occupational injury and fatalities are approximately three

³⁵ Adapted from Bureau of Labor Statistics, *Employer-Reported Workplace Injuries and Illnesses* Table 1.

³⁶ Houser et al., *Emergency Responder Injuries and Fatalities*, xv.

³⁷ Reichard and Jackson, *Occupational Injuries among Emergency Responders*, 1.

³⁸ Ibid.; Houser et al., *Emergency Responder Injuries and Fatalities*.

times more prevalent among first responders, and that sprains, contusions, and lacerations are the three most common types of injury.³⁹

The BLS does collect some information on first responders in their SOII; however, data on state and local government employees is only collected from select states, and only since 2008 (the number of participating states has steadily increased since the Bureau started to keep track).⁴⁰ In 2014, the SOII included data from state and local government employees in 41 states (see Table 2). The incidence rates for the three subgroups ranged from 7.9 to 12.1.⁴¹

Table 2. Incidence Rates of Nonfatal Occupational Injuries among First Responders, 2014⁴²

Industry		Total Recordable Cases	Cases with Days away from Work, Transfer, or Restriction
All Industries		3.4	1.8
	Ambulance Services	7.9	5.0
	State and Local Government	5	2.3
	Justice, Public Order, Safety	9.5	4.8
	Police Protection	10.6	5.0
	Fire Protection	12.1	7.6

Incidence rates of nonfatal occupational injuries for ambulance, police, and fire services and their North American Industry Classification System (NASICS) sectors.

³⁹ Houser et al., *Emergency Responder Injuries and Fatalities*, 32, 51; Reichard and Jackson, *Occupational Injuries among Emergency Responders*, 7.

⁴⁰ Shannon M. Maloney, "Nonfatal Injuries and Illnesses among State and Local Government Workers, Bureau of Labor Statistics, March 2014, <https://www.bls.gov/spotlight/2014/soii-gov-workers/home.htm>.

⁴¹ Bureau of Labor Statistics, *Employer-Reported Workplace Injuries and Illnesses*.

⁴² Adapted from Bureau of Labor Statistics, *Employer-Reported Workplace Injuries and Illnesses*, Table 1.

Additionally, the data collected over the past six years (see Figure 2 and Figure 3), demonstrate a general trend of decreasing injury rates among first responders, but with less of a clear trend when compared to the general population and state and local government employees in general.⁴³

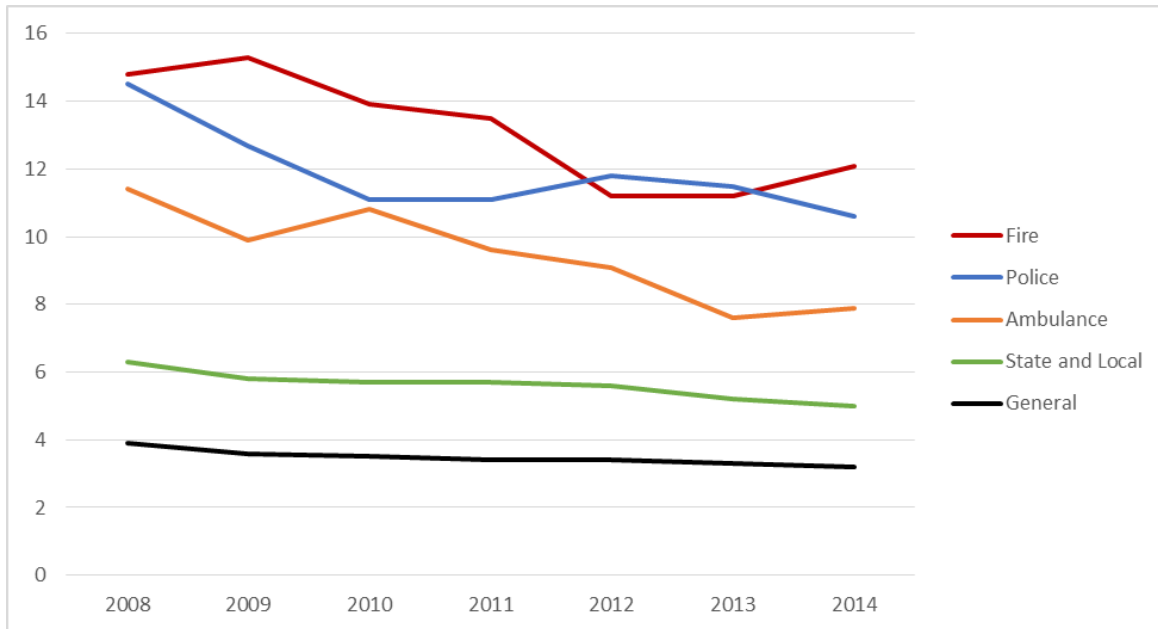
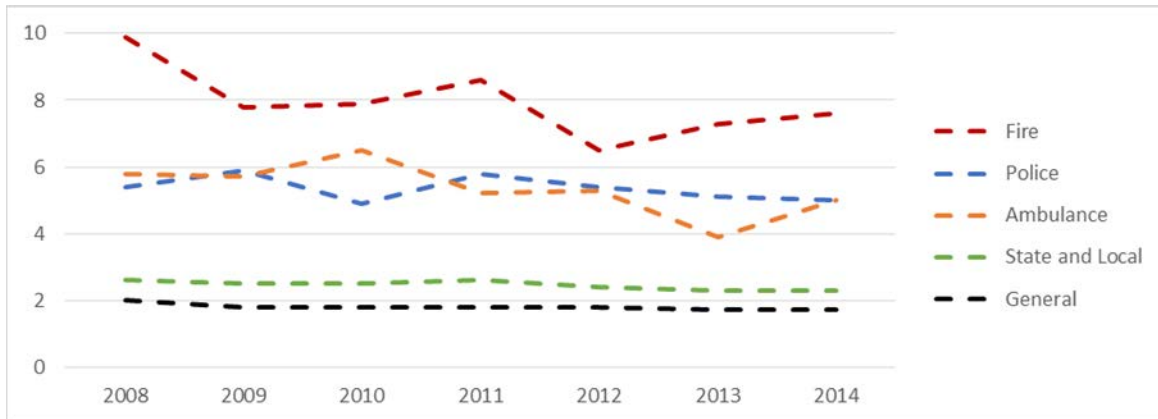


Figure 2. Total Incidence Rate among First Responder Categories, 2008–2014⁴⁴

⁴³ Bureau of Labor Statistics, *Employer-Reported Workplace Injuries and Illnesses*.

⁴⁴ Adapted from Bureau of Labor Statistics, *Employer-Reported Workplace Injuries and Illnesses*, Table 1.



Incidence rates of nonfatal injuries resulting in days away from work, transfer, or restriction.

Figure 3. Days away from Work Rate among First Responder Categories, 2008–2014⁴⁵

In 2004, RAND published a study entitled *Emergency Responder Injuries and Fatalities: An Analysis of Surveillance Data*, which quantified injury data from various sources on first responders, including the National Fire Protection Association, U.S. Fire Administration, National Fire Incident Reporting System, National Law Enforcement Officer Memorial Fund Database, and National EMS Memorial Service Database.⁴⁶ Their analysis focused heavily on firefighter injuries, for which the largest amount of data was available. Based on their analysis, the average incidence rate for firefighters between 1995 and 2000 was 8.0 cases per 100 workers.⁴⁷

In 2010, a follow-up report published in the *American Journal of Industrial Medicine* corroborated these rates based on the National Electronic Injury Surveillance system for injuries treated in hospital emergency departments. The study found that police and firefighters had injury incidence rates of 8.5 and 7.4 injuries per 100 workers, respectively.⁴⁸

⁴⁵ Adapted from Bureau of Labor Statistics, *Employer-Reported Workplace Injuries and Illnesses*, Table 1.

⁴⁶ Houser et al., *Emergency Responder Injuries and Fatalities*, 13–23.

⁴⁷ Incidence rate was determined by dividing the count of reported non-fatal injuries (87,900) by the included population (1,100,000). *Ibid.*, 37, 53.

⁴⁸ Reichard and Jackson, *Occupational Injuries among Emergency Responders*, 1–11.

C. INJURY RATES AMONG RESPONDERS IN DISASTERS

Injury data among responders in disasters is generally limited to event-specific data collection. Events were selected for inclusion if the event exceeded the capacity of local and state governments, and had available data on occupational injuries among responders; as a result, all selected events included local, state, and federal response components. For each selected event, a brief description of the nature of the event is provided, as is a summary of the responder safety issues, the injury rates for responders (or a subset of responders, depending on availability), and the estimated annualized rate of injury.

1. Oklahoma City Bombing

The Oklahoma City bombing occurred on April 19, 1995, after a truck bomb exploded at a federal building in downtown Oklahoma City.⁴⁹ Rescue and recovery operations continued through May 4, 1995; approximately 12,000 responders participated in rescue operations.⁵⁰

Shortly after the onset of the disaster, the Oklahoma City Fire Department (OCFD) established safety officers to monitor responders, the damaged building, and the overall site.⁵¹ Nevertheless, there was no standard form for reporting injuries during the recovery.⁵² Following the recovery efforts, there was some interest among the medical community on responder safety, and a subsequent study was published in the *American Journal of Industrial Medicine*. The study reviewed medical records from hospital emergency departments and specialty clinics and calculated estimated injury rates (see Table 3) among the two largest group of responders, the OCFD and the FEMA Urban Search and Rescue Teams (USAR).

⁴⁹ U.S. Department of Justice, *Responding to Terrorism Victims: Oklahoma City and Beyond* (NCJ 183949) (Washington, DC: U.S. Department of Justice, 2000), Chapter II.

⁵⁰ BP, “Deepwater Horizon Incident Response Recordable Injury & Illness Data,” OSHA, accessed February 10, 2017, <https://www.osha.gov/oilspills/DeepwaterData.pdf>.

⁵¹ Dellinger, Waxweiler, and Mallonee, “Injuries to Rescue Workers,” 730.

⁵² Ibid.

Table 3. Oklahoma City Bombing Responder Injury Rates⁵³

Agency	Injuries	Responders	Reported Injuries per Hour Rate	Annualized Injury Incidence Rate
OCFD	28	932	0.0015	13.14
USAR	68	658	0.0012	10.51
Combined	96	1590	0.0014	12.05

The estimated annualized injury rate among responders in the Oklahoma City bombing was 12.05; the most common injuries were sprains, lacerations, and eye injuries (see Figure 4). The study determined that at least two types of injuries were preventable: both chemical burns and foot injuries could have been reduced with proper training and better logistics support, respectively.⁵⁴ Additionally, the study postulated that eye injuries may have been preventable, but that there was insufficient data to make a definitive conclusion.⁵⁵

⁵³ Adapted from Dellinger, Waxweiler, and Mallonee, "Injuries to Rescue Workers," 729. Annualized rate calculated by adjusting the studies determined injuries per hour rate to an annual rate of injury. Combined rates determined using a weighted average of both agencies.

⁵⁴ Ibid., 730

⁵⁵ Ibid.

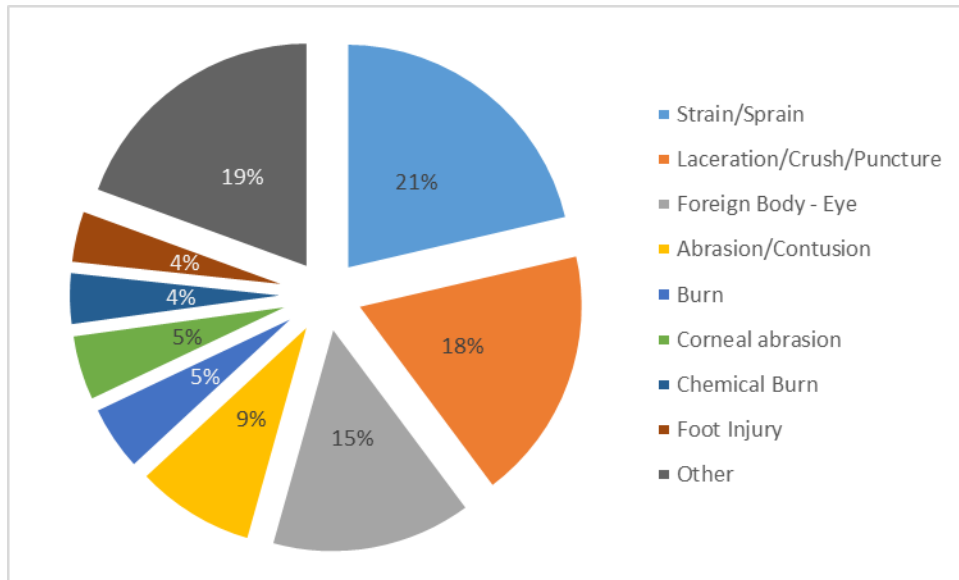


Figure 4. Oklahoma City Bombing Reported Injury Types⁵⁶

2. World Trade Center

The World Trade Center attack occurred on September 11, 2001, when two hijacked planes crashed into the WTC's north and south towers, leading to their eventual collapse later that day. An estimated 40,000 responders worked at Ground Zero for the subsequent nine-month recovery, conducting rescue operations, service restoration, and debris cleanup.⁵⁷

In the initial weeks, there was no unified occupational health screening or reporting for responders.⁵⁸ However, starting in 2002, WTC responders began to receive some of the most comprehensive occupational health screening and tracking programs. One of these, the World Trade Center Worker and Volunteer Medical Screening Program, performed an extensive survey of responders. Of the 7,810 participants, 2,486

⁵⁶ Adapted from Dellinger, Waxweiler and Mallonee, "Injuries to Rescue Workers," 729, Table 1.

⁵⁷ Robin Herbert et al., "The World Trade Center Disaster and the Health of Workers: Five-Year Assessment of a Unique Medical Screening Program," *Environmental Health Perspectives* 114, no. 12 (December, 2006): 1853.

⁵⁸ *Ibid.*, 1854.

reported at least one injury or illness requiring medical treatment during the recovery (see Table 4).⁵⁹

Table 4. World Trade Center Recovery Injury Incidence Rates⁶⁰

Industry	Participants	Participants Reporting an Injury	Injury/Illness Incidence Rate per 100	Annualized Injury/Illness Incidence Rate
Construction	2,623	806	30.7	41.0
Law Enforcement	2,036	675	33.2	44.2
Other	2,892	911	31.5	42.0
Unknown	259	94	36.3	48.4
Total	7,810	2,486	31.8	42.4

Injury and illness cases and incidence rate, and an annualized rate based on the nine-month recovery period.

The most common injuries were respiratory and traumatic injuries, such as lacerations, contusions, and punctures (see Figure 5).⁶¹ Many of the health effects, particularly the respiratory issues, persisted or worsened over time, often developing into chronic disorders that require long-term monitoring.⁶²

⁵⁹ Perritt et al., “Work-Related Injuries and Illnesses.”

⁶⁰ Adapted from Perritt et al., “Work-Related Injuries and Illnesses,” Table 1.

⁶¹ Ibid., 401–407.

⁶² Bascetta, *September 11*, 8.

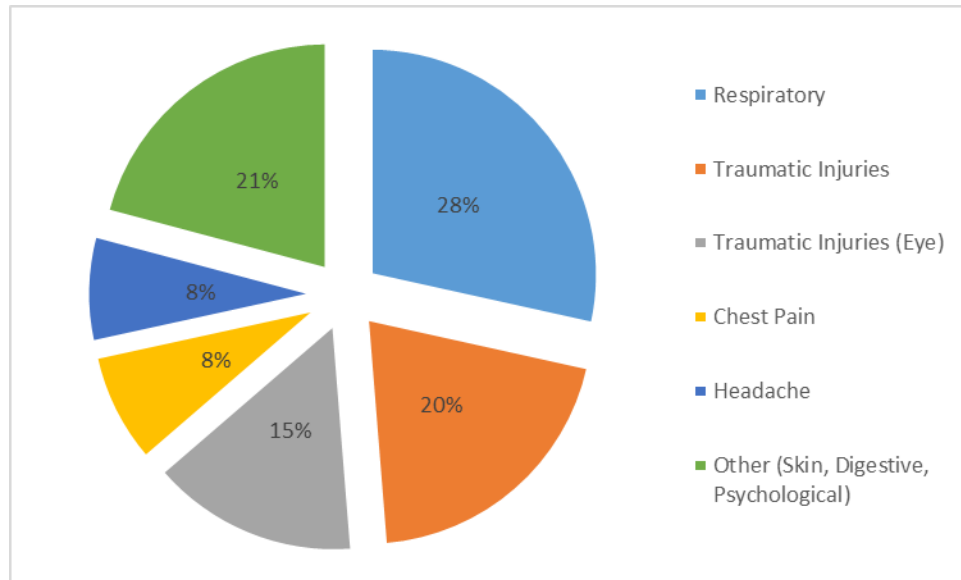


Figure 5. World Trade Center Injuries⁶³

Surveys of WTC responders indicated that improper (or absent) use of personal protective equipment (PPE), especially respiratory protection, may have been the primary cause of more than 25 percent of all injuries or illness for responders.⁶⁴ While the initial problem was a simple equipment shortage, respiratory protection compliance still remained low after the equipment's widespread availability.⁶⁵ After the WTC response, OSHA recognized the need to ensure PPE availability before a future incident and incorporated it into the Worker Safety and Health Support Annex to the National Response Framework.

⁶³ Adapted from Perritt et al., "Work-Related Injuries and Illnesses," Table 2.

⁶⁴ William A. Groves et al., "Protecting First Responders: Analysis of PPE Guidelines Distributed at the World Trade Center and Pentagon Disaster Sites," *Professional Safety* 49, no. 11 (November 1, 2004)

⁶⁵ *Ibid.*, 40.

3. Hurricane Katrina

On August 29, 2005, Hurricane Katrina made landfall on the Gulf Coast, causing widespread damage in Alabama, Louisiana, and Mississippi.⁶⁶ It is estimated that almost 50,000 federal employees responded at the height of the events and tens of thousands more state and local responders responded as well.⁶⁷

During the event, there was no centralized or organized collection of injury data among recovery workers.⁶⁸ Although OSHA was responsible for at least the federal workers under the “Worker Safety and Health Annex” to the National Response Framework, OSHA did not receive a mission assignment from FEMA to pay for activities, and federal agencies had not developed a process for the uniform collection of data in a disaster response.⁶⁹

The GAO conducted a review of worker safety and OSHA’s performance in Hurricane Katrina and published the data in 2007. During the GAO’s research, they requested that each of the ten federal agencies that responded submit data on worker injuries. However, only four of those agencies kept sufficient records to report on: the Environmental Protection Agency (EPA), the United States Army Corps of Engineers (USACE), the Coast Guard, and the Department of the Interior.⁷⁰ While detailed injury data is available in published sources for each of these agencies, corresponding records detailing the total number of employees deployed to Katrina are not. To calculate the incident rate, the number of employees for each agency had to be estimated based on best available data, including news reports, government reports, and agency publications from the time. As a result, the incidence rates (see Table 5) for workers during Hurricane Katrina are at best a rough estimate.

⁶⁶ GAO, *Disaster Preparedness*, 1.

⁶⁷ *Ibid.*, 11.

⁶⁸ *Ibid.*, 2.

⁶⁹ *Ibid.*

⁷⁰ *Ibid.*, 50–52.

Table 5. Hurricane Katrina Federal Worker Incidence Rate⁷¹

Agency	Reported Period	Months	Injuries	No. of Workers	Annualized Incidence Rate
EPA	Aug 2005–Jun 2006	10	124	1,200	12.40
USCAE	Aug 2005–Jun 2007	10	562	3,100	21.75
Coast Guard	Nov 2005–Mar 2006	5	555	5,600	23.79
Dept. of Interior	Aug 2005–Apr 2006	8	90	2,304	5.86
Overall Weighted Average:					18.77

Of those four agencies, over 3,000 injuries and illness were reported.⁷² The most common injuries were from insect and animal bites; heat stress; and exposures to chemicals, infections or biological agents, floodwater, mold, and carbon monoxide.⁷³ Additionally, in New Orleans following Hurricane Katrina responders reported cases of communicable diseases such as pneumonia, rashes, and sinus infections.⁷⁴ Surveillance conducted by the Centers for Disease Control and Prevention (CDC) and the Louisiana Department of Health and Hospitals in the immediate aftermath of Katrina corroborate these types of injuries.⁷⁵ They reviewed cases of injury treatment in New Orleans–area hospitals and clinic from September 8–October 14, 2005, and found that the most

⁷¹ Total injury counts, injury annualized incidence rate, and the number of EPA workers, based on GAO, *Disaster Preparedness*, Appendix II, 48–58; USACE no of workers based on deployed personnel reported in Mike Pfenning, “District Supports Hurricane Recovery; Hurricane Response Delays New Personnel System,” *Crosscurrents* 28, no. 9 (October 2005): 2; Coast Guard workers based on overall deployed personnel estimated by the GAO and reported in Rusiecki et al. “Disaster-Related Exposures and Health Effects, 822 and corroborated in “The U.S. Coast Guard & Hurricane Katrina,” U.S. Coast Guard, last modified December 21, 2016, <http://www.uscg.mil/history/katrina/katrinaindex.asp>; Department of Interior Workers based on deployed personnel reported in “Hurricanes Katrina and Rita,” U.S. Department of the Interior, last modified April 26, 2006, <https://www.doi.gov/emergency/factsheets/hurricanes-katrina-and-rita>.

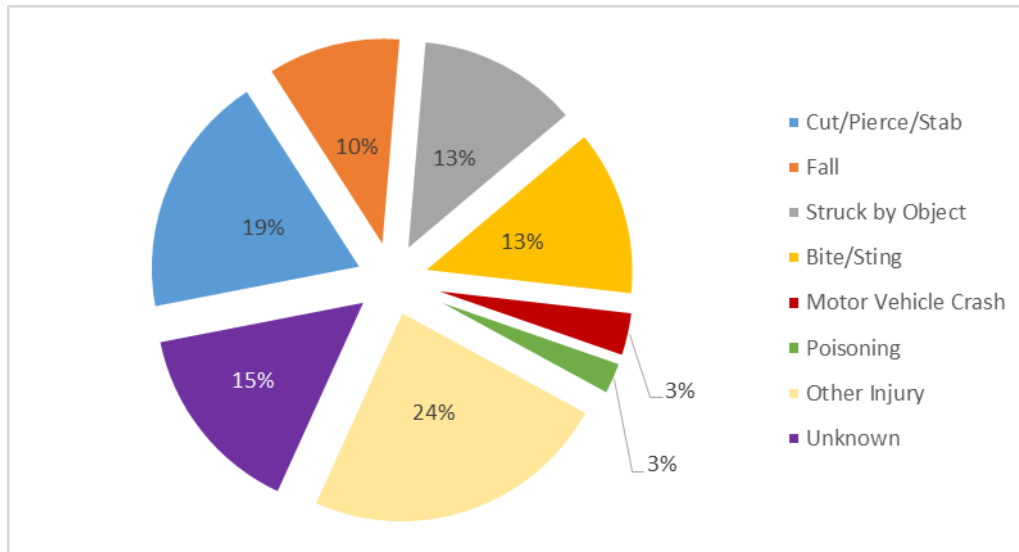
⁷² GAO, *Disaster Preparedness*, 13–17.

⁷³ Ibid.

⁷⁴ CDC, “Infectious Disease and Dermatologic Conditions in Evacuees and Rescue Workers after Hurricane Katrina—Multiple States, August–September, 2005,” *MMWR: Morbidity & Mortality Weekly Report* 54, no. 38 (September 26, 2005): 961–964.

⁷⁵ Ernest E. Sullivent III et al., “Nonfatal Injuries Following Hurricane Katrina—New Orleans, Louisiana, 2005,” *Journal of Safety Research* 37, no. 2 (2006): 215–216.

common injuries among responders were lacerations, falls, struck by an object, and animal bites (see Figure 6).⁷⁶



Most common injury types among responders seeking assistance from medical facilities in New Orleans from September 8–October 14, 2005.

Figure 6. CDC Injury Surveillance after Hurricane Katrina⁷⁷

The CDC noted that injuries by toxic effects were much less common than the GAO found during their review, making up only 2.6 percent of injuries noted among responder seeking treatment in New Orleans hospitals.⁷⁸ Unfortunately, injury rates cannot be established based on the CDC data, as there is insufficient information available to estimate the total count of responders in that particular area at the time of the surveillance.⁷⁹

The GAO found that the level of health and safety training and equipment provided in the Gulf area fell well below established federal standards.⁸⁰ For example,

⁷⁶ Ibid.

⁷⁷ Adapted from Sullivent III et al., “Nonfatal Injuries Following Hurricane Katrina, 215, Table 2.

⁷⁸ Ibid.

⁷⁹ Ibid.

⁸⁰ GAO, *Disaster Preparedness*, 16

while utility workers were well trained on how to safely handle downed power lines, some were unaware of the need for additional PPE, such as boots with steel shanks to protect them from puncture wounds from debris containing nails and other sharp objects.⁸¹

4. Deepwater Horizon

The Deepwater Horizon oil spill began on April 20, 2010, following the explosion and sinking of the BP oil rig of the same name.⁸² The explosion ruptured the oil well resulting in the unprecedented release of 4.9 million barrels of oil over 87 days until the well was capped on July 15, 2010.⁸³ Approximately 55,000 workers responded to assist with the containment and cleanup of the oil spill.⁸⁴

During the response operation, OSHA, the National Institute for Occupational Safety and Health, and BP worked closely to ensure that injuries and illness were recorded in accordance with OSHA regulatory requirements.⁸⁵ As a result, Deepwater Horizon has some of the most extensive injury records for a disaster of its magnitude.

BP has made available the recordable injury and illness data from April 22, 2010, to July 12, 2010; this includes all responders except those employed by local, state, or federal government agencies.⁸⁶ During this period, BP reported a total incidence rate of 2.37 for the 91-day period (see Table 6).⁸⁷ Annualized, this result is an incidence rate of 9.5 injuries per 100 workers.

⁸¹ Ibid.

⁸² National Response Team, *On Scene Coordinator Report on Deepwater Horizon Oil Spill* (Washington, DC: U.S. Coast Guard, 2011), 1.

⁸³ Ibid.

⁸⁴ Bernard D. Goldstein, Howard J. Osofsky, and Maureen Y. Lichtveld, "The Gulf Oil Spill," *New England Journal of Medicine* 364, no. 14 (April, 2011): 1334–1348, doi: 10.1056/NEJMra1007197.

⁸⁵ CDC, "NIOSH Report of Deepwater Horizon Response/BP Illness and Injury Data."

⁸⁶ BP. "Deepwater Horizon Incident Response Recordable Injury & Illness Data."

⁸⁷ Ibid.

Table 6. BP Deepwater Horizon Injury Incidence Rate, April 22–July 12, Annualized⁸⁸

	Incident Rate	Illness Rate	Injury Rate	Days away from Work Rate
April 22 to July 12 (91 Days)	2.37	0.65	1.71	0.14
Annualized Rate	9.51	2.61	6.86	0.56

The most common injuries during the response were lacerations, sprains, and contusions (see Figure 7).⁸⁹ The long-term health effects from Deepwater Horizon are still unclear. The Gulf long-term follow-up study was initiated by the National Institute of Environmental Health Sciences in June 2010 and is still ongoing.

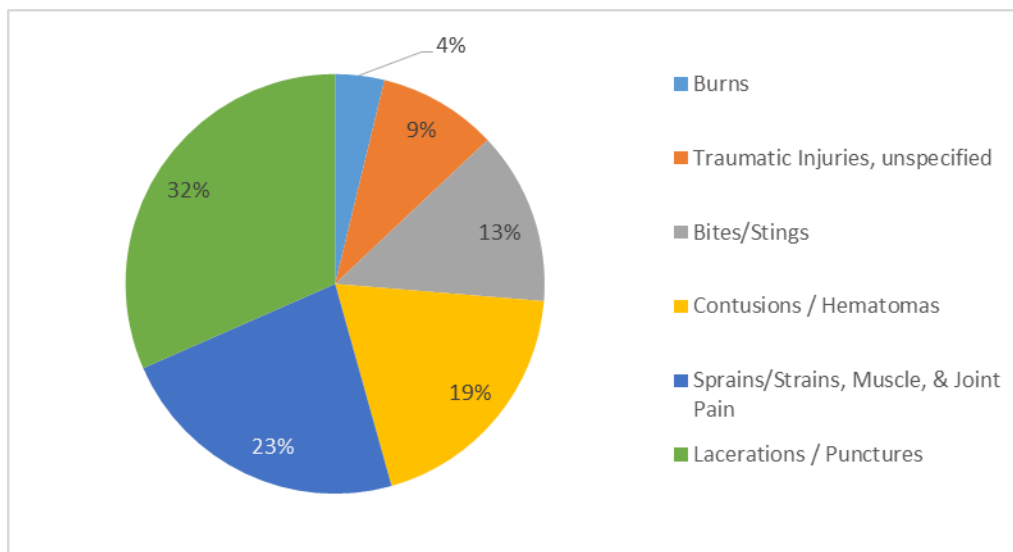


Figure 7. Deepwater Horizon Most Common Injuries by Nature of Injury, April 23–July 8, 2010⁹⁰

⁸⁸ Adapted from BP. “Deepwater Horizon Incident Response Recordable Injury & Illness Data.”

⁸⁹ CDC, “NIOSH Report of Deepwater Horizon Response/BP Illness and Injury Data,” 8.

⁹⁰ Adapted from CDC, “NIOSH Report of Deepwater Horizon Response/BP Illness and Injury Data,” Graph 3.

D. FATALITIES AMONG RESPONDERS IN DISASTERS

Fortunately, research has shown that fatalities among disaster responders are uncommon and, unlike injury rates, the CFOI catalog of fatal workplace injuries provides extensive information on fatalities broken down by event. Few studies have been conducted on the correlation between responder fatalities and disaster response. However, a 2009 study published in the *Journal of Disaster Medicine and Public Health Preparedness* closely examined the CFOI data for natural disasters between 1992 and 2006.⁹¹ The study found a total of 307 occupational fatalities among disaster responders, averaging approximately 20 fatal injuries per year. It is important to note that this study excluded terrorist events such as the WTC tragedy in calculating total fatalities, as the events drastically skewed average fatalities per year. Fatalities were most common during hurricanes, wildfires, and floods (see Figure 8).⁹² All but four of the fatalities were tied to either a particular hazardous condition caused by the disaster or to the particular type of work that was being performed. In 39 percent of the cases the cause of the fatality was tied primarily to a particular hazard, in 33 percent to the particular work of the responder, and in 27 percent to both factors.⁹³

The cause of the fatalities establishes that, during the study period, the predominant cause of death was either exposure to the disaster conditions or the actual disaster-related work. The primary cause of mortality during wildfires, for example, was exposure to fire.⁹⁴ During flooding, the primary cause was drowning, primarily among responders in vehicles attempting to transverse flooded roadways to or from the incident.⁹⁵

⁹¹ Gregory M. Fayard, "Fatal Work Injuries Involving Natural Disasters, 1992–2006," *Disaster Medicine and Public Health Preparedness* 3, no. 4 (December, 2009): 201–209, doi:10.1097/DMP.0b013e3181b65895.

⁹² Ibid.

⁹³ Ibid.

⁹⁴ Ibid.

⁹⁵ Ibid.

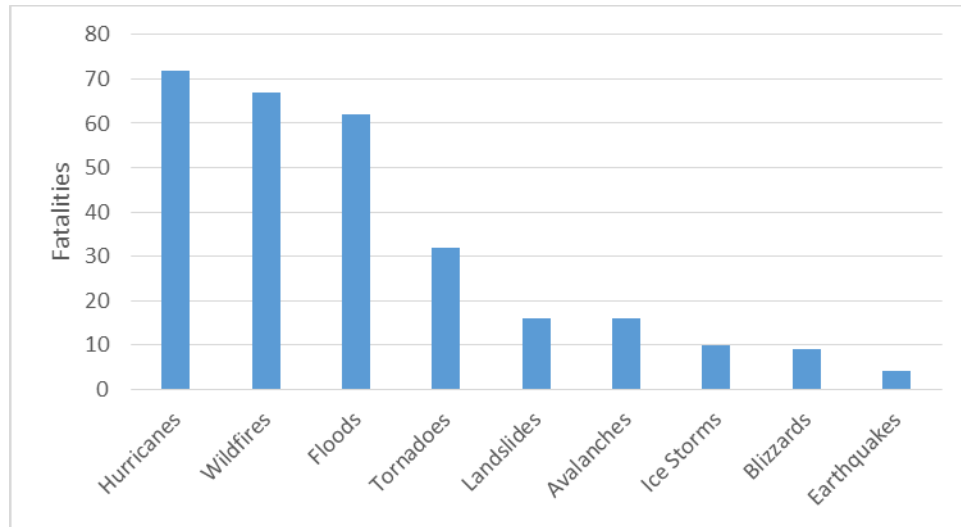


Figure 8. Occupational Fatalities among Natural Disaster Responders, 1992–2006⁹⁶

The study also found that government workers were far over-represented among deaths in disasters when compared to overall worker fatality rates (see Table 7). Between 1992 and 2006, public sector employees made up about 10 percent of fatal work injuries; however, when reviewing deaths due to natural disasters during the same period, they comprised 31 percent of fatalities.⁹⁷ The correlation is even more pronounced among federal employees, increasing five-fold from 3 percent to 16 percent.⁹⁸ This drastic increase in mortality rates of public employees during disasters is an indicator of the increased risk the employees face during disaster operations.

⁹⁶ Adapted from Fayard, “Fatal Work Injuries Involving Natural Disasters,” 203.

⁹⁷ Ibid.

⁹⁸ Ibid.

Table 7. Major Characteristics of Fatal Work Injuries Overall and for Natural Disasters, 1992–2006⁹⁹

	All Fatal Work Injuries		All Natural Disasters		Wildfires		Hurricanes		Floods	
	No.	%	No.	%	No.	%	No.	%	No.	%
Total	90,286	100	307	100	80	100	72	100	62	100
Public (by sector)	9,122	10	95	31	47	59	15	21	20	32
Federal	2,506	3	49	16	32	40	6	8	5	8
State	1,737	2	19	6	9	11	-	-	5	8
Local	4,759	5	25	8	6	8	6	8	10	16
Protective Services (by Occupation)	4,218	5	73	24	51	64	5	7	12	19
Firefighting	681	1	59	19	51	64	-	-	5	8
Law Enforcement	2,199	2	7	2	-	-	-	-	-	-

⁹⁹ Adapted from Fayard, “Fatal Work Injuries Involving Natural Disasters,” 204.

IV. INJURY ANALYSIS

The nature of the problems across multiple disasters and years demonstrates continued failures when it comes to responder safety. For all four events analyzed in detail in this thesis, the rate of injury among responders was noticeably higher than that of both the general population and first responders in their day-to-day roles (see Figure 9). Additionally, the most common injuries noted, lacerations, sprains, and contusions, were common among all of the noted disasters.

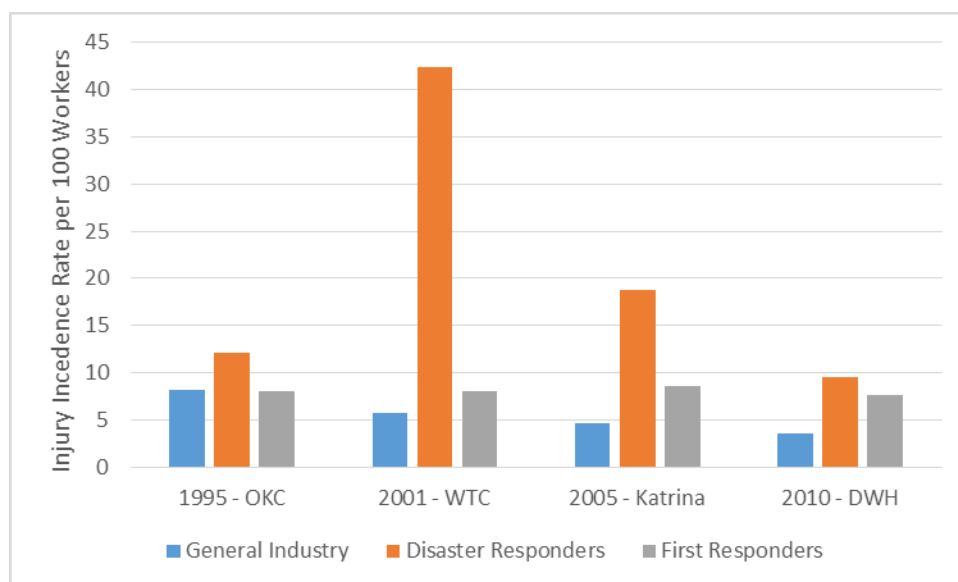


Figure 9. Injury Incidence Rate Comparison¹⁰⁰

GAO reports on both the WTC events and Hurricane Katrina have indicated continued systematic failures in integration and implementation of safety during disasters and have shown that, even when the needed resources are provided, enforcement and compliance among responders can remain low.¹⁰¹ The research has indicated that there are, for most cases, already sensible policies in place that should prevent injuries; it is the enforcement or implementation that results in unneeded injury.

¹⁰⁰ Adapted from data collected and shown in prior figures.

¹⁰¹ GAO, *Disaster Preparedness*; Bascetta, *September 11*.

For example, the Department of Homeland Security and its component FEMA established the National Response Framework, which, in cooperation with OSHA, includes the Worker Safety and Health Support Annex. The annex calls for hazard identification, environmental sampling, personal exposure monitoring, collecting and managing exposure data, development of site-specific safety plans, immunization and prophylaxis, and medical surveillance, medical monitoring, and psychological monitoring during a disaster.¹⁰² As is demonstrated in this chapter, these actions should provide substantial protection from responder injury in disasters, especially when coupled with existing federal, state, and local policies. However, enforcement is lacking.

In fact, in disasters going back to at least the 1989 Exxon Valdez Oil Spill, OSHA has temporarily suspended enforcement in specific areas to expedite recovery.¹⁰³ OSHA instead relies on providing technical assistance to responders as an alternative to formal enforcement action.¹⁰⁴ OSHA has asserted that this method provides the best balance in recovery since enforcement actions do not take effect until after the appeal process is over, which can drastically delay abatement.¹⁰⁵ In most cases, however, employers forgo an appeal and resolve OSHA citations within fifteen days.¹⁰⁶

During Hurricane Sandy, records collected by OSHA indicate that federal inspectors in the New York metropolitan area noted thousands of instances of unsafe job conditions among responders, but in most cases only issued a warning to fix the problem.¹⁰⁷ Reports indicate that the issues often went unfixed even after warnings, as

¹⁰² “Worker Safety and Health Support Annex,” FEMA, accessed February 10, 2017, <https://www.fema.gov/pdf/emergency/nrf/nrf-support-wsh.pdf>.

¹⁰³ David M. Newman, “Protecting Worker and Public Health during Responses to Catastrophic Disasters—learning from the World Trade Center Experience,” *American Journal of Industrial Medicine* 57, no. 11 (2014): 1285–1298; Torres, “Legislators Question Enforcement Suspension After Disasters.”

¹⁰⁴ GAO, *Disaster Preparedness*. .

¹⁰⁵ Newman, “Protecting Worker and Public Health during Responses,” 1288

¹⁰⁶ Ibid.

¹⁰⁷ Erica Pearson and Greg B. Smith, “‘CANE, THEN DEATH & PAIN: Safety often Ignored in Cleanup Work Feds Find 1,000s of Violations but Issue Few Fines,” *New York Daily News*, April 28, 2013.

enforcement actions were rare.¹⁰⁸ During Hurricane Sandy, OSHA issued only 32 formal violations with only minimal fines between \$1,000 and \$11,600.¹⁰⁹

A. EXTENDED WORK HOURS

Even when followed, OSHA standards fail to address extended work schedules.¹¹⁰ It is typical in a disaster recovery environment to see strenuous work schedules with few breaks. During the WTC recovery, twelve-hour shifts and seven-day workweeks were normal among responders, resulting in prolonged periods of exposure to additional risk.¹¹¹ A study into the health effects of Hurricane Katrina found that “given the high pace of the response and the resulting long hours for responders ... mental and physical stressors were potentially significant influences on the health and well-being of responders.”¹¹²

The long shifts are exacerbated by short sleep duration and erratic sleep patterns.¹¹³ Research has shown that when responders receive less than five hours of sleep per night, they experience a threefold increase in slips, trips, and falls, muscle strain, dehydration, and depression.¹¹⁴

B. HAZARD CONTROL AND INJURY REDUCTION

The National Institute for Occupational Safety and Health has identified that, in disasters, “managing [responder] safety is more accurately described as managing their level of risk.”¹¹⁵ Normal safety procedures, which many agencies have identified for day-to-day operations, may not be practical in the early stages of disasters.¹¹⁶ Injury reduction

¹⁰⁸ Ibid.

¹⁰⁹ Ibid.

¹¹⁰ Newman, “Protecting Worker and Public Health during Responses,” 1285–1298, 1289.

¹¹¹ Ibid.

¹¹² Rusiecki et al., “Disaster-Related Exposures and Health Effects,” 820.

¹¹³ Ibid., 830.

¹¹⁴ Ibid.

¹¹⁵ Houser et al., *Emergency Responder Injuries and Fatalities*.

¹¹⁶ “Emergency Response Resources,” CDC, last updated December 2, 2016, <https://www.cdc.gov/niosh/topics/emres/responders.html>.

is accomplished by reducing the hazard to injury; traditionally there is a three-tiered hierarchy of control to assist in reducing or eliminating hazards. The first and generally most effective means is to control the hazard source (either by removing or reducing the hazard), the second is to use engineering controls in the physical environment to separate the worker from the hazard, and the third is to use personal protective equipment.¹¹⁷

Controlling the hazard source is generally impractical during disasters. In manufacturing you might control a hazard by avoiding the use of toxic chemicals, removing tripping hazards, or using non-flammable materials. However, it is neither practical nor realistic to remove a hurricane, earthquake, or other disaster. In fact, in most cases it is the responders who will eventually be responsible for the removal of the effects of the disaster.

It can also be impractical to implement control over the source of a hazard or to install engineered controls during the initial response to a disaster. Examples of engineering controls include isolating areas using handrails or blockades, utilizing ventilation systems, enclosing hazard sources, or using mechanical or automated options over manual methods.¹¹⁸ However, after twenty-four to seventy-two hours, the need for life-saving rescue operations caused by the disaster diminishes. Once rescue operations are over and there is no longer an immediate risk to lives, more effective hazard control can be put in place to provide protection to responders.¹¹⁹ For example, in the immediate aftermath of an earthquake, responders prioritize removing trapped survivors from buildings over installing permeant barriers around weakened areas in a building.

Unlike controls over the source of a hazard or engineered controls, personal protective equipment (PPE) can be implemented at any time as long as the equipment is available. PPE works by providing a last line of defense for a responder, and includes

¹¹⁷ Newman, "Protecting Worker and Public Health during Responses."

¹¹⁸ "Chemical Hazards and Toxic Substances," OSHA, accessed February 10, 2017, <https://www.osha.gov/SLTC/hazardoustoxicsubstances/control.html>.

¹¹⁹ Ibid.

items such as gloves, respiratory protection, and steel-toe boots.¹²⁰ Due to the importance of PPE, it is analyzed in depth in the next section.

The two phases of a disaster are generally identified as response and recovery. During the initial response phase, the focus is usually to stop the immediate threat to life or property, and to reach trapped or injured survivors. During this phase, the risk analysis weighs heavily on saving the most lives in the limited amount of time available. The recovery phase can be much longer, lasting months or even years, and focuses on the restoration of the impacted area.¹²¹ During the recovery phase, the risk analysis shifts; the benefit is no longer saving lives, but getting the community back to its pre-disaster condition. This distinction is important because the level of acceptable risk to responders should be weighed against the potential benefit. It is important to adjust the risk analysis as response operations give way to recovery. Failing to do so can result in taking unnecessary risks with the safety of responders. For example, during the WTC recovery, the City of New York extended the rescue phase to include the entire nine months of debris removal.¹²² The mayor's office was under considerable pressure to open more of the city for reoccupation, and the result was an attempt to return to normalcy rapidly; for many this meant de-emphasizing risk.¹²³ For workers at the WTC, this extended designation created substantial obstacles to implementing safe work practices and enforcing safety regulations.¹²⁴

Establishing safety procedures and guidelines, and installing additional hazard control measures was seen as an impediment to the rescue of victims and the retrieval of body parts.¹²⁵ In the case of the WTC, even though the last survivor was rescued less than twenty-four hours after the attack, this meant that training on proper respiratory use was delayed at least three weeks, and the establishment of a formal

¹²⁰ Bill Bennett, "PPE for Disaster Workers: Planning Ahead Saves Lives," *Industrial Safety and Hygiene News* 44, no. 9 (September 2010): 50–53.

¹²¹ Newman, "Protecting Worker and Public Health during Responses," 1285–1298.

¹²² *Ibid.*, 1288

¹²³ *Ibid.*

¹²⁴ *Ibid.*

¹²⁵ *Ibid.*

safety program was delayed four weeks. In the first nine weeks after the WTC attack, almost 1,000 responders reported respiratory injuries; NIEHS investigators reviewing injury rates between September 14 and 25, 2001, noted that injury rates were “far above the national average.”¹²⁶

C. PERSONAL PROTECTIVE EQUIPMENT

The provision of training and equipment before a disaster event has been identified numerous times as paramount to workers’ ability to efficiently and safely respond to disasters.¹²⁷ Responders proceeding with missing or incomplete equipment can be placed in harm’s way, resulting in injuries or illness that will prevent them from continuing to perform their duties.

During the WTC recovery, a CDC study indicated that respirator wear rates were as low as 21 percent among responders.¹²⁸ The CDC believes that many of the respiratory problems could have been prevented if responders had used respirators while on site. Initially there was a limited supply of respirators for responders; however, even when they were made widely available to responders, use was rare due to a lack of training and proper fit-testing.¹²⁹ Additionally, since respirators can be uncomfortable in physically demanding conditions, provision alone may not have been adequate. When responders are properly equipped and trained, discomfort and convenience have been identified as the two primary reasons for not using respiratory protection; prior studies have identified that supervision and enforcement are likely to increase compliance rates.¹³⁰

During Hurricane Katrina, similar issues arose with the availability and provision of PPE.¹³¹ The GAO found that the level of health and safety training and

¹²⁶ Ibid.

¹²⁷ Pearson and Weinstock, “Minimizing Safety and Health Impacts at Disaster Sites,” 1–16.

¹²⁸ Ibid., 4

¹²⁹ Ibid.

¹³⁰ Newman, “Protecting Worker and Public Health during Responses,” 1292; Groves et al., “Protecting First Responders,” 41.

¹³¹ GAO, *Disaster Preparedness*, 34.

equipment provided in the Gulf area fell well below established federal standards.¹³² These conditions were exacerbated among certain responders, such as day laborers working debris removal who were often provided with no protective equipment even when the debris was determined to be toxic.¹³³

Responders working in the devastated regions flooded by Hurricane Sandy faced dangerous mold and asbestos contamination similar to both the WTC and Hurricane Katrina responses. Within the first month of response operations, OSHA agents working in Sandy-affected areas identified 17,481 instances of safety issues with responders.¹³⁴ Of those instances, around 6,500 of the affected workers had to be removed from hazardous conditions, including some who lacked proper PPE.¹³⁵

D. TRAINING

Shortly after Hurricane Katrina, the National Institute of Environmental Health Sciences identified training as a major systems failure of both Hurricane Katrina and WTC responses.¹³⁶ They noted that most resources are dedicated to just-in-time and short-term training, and that responder safety training is simply not prioritized outside of disasters.¹³⁷ Studies have shown that just-in-time and on-site training does not adequately prepare responders to safely conduct themselves in a disaster environment.¹³⁸

Just-in-time training should focus on site-specific hazards and procedures, reinforcing existing training rather than attempting to cover everything in a short and

¹³² Ibid., 37.

¹³³ Linda Delp, Laura Podolsky, and Tomás Aguilar, “Risk amid Recovery: Occupational Health and Safety of Latino Day Laborers in the Aftermath of the Gulf Coast Hurricanes,” *Organization & Environment* 22, no. 4 (October 2009): 480.

¹³⁴ Lynne Peeples, “Sandy Cleanup could Lead to Illness, Litigation for Workers,” *Huffington Post*, December 5, 2012, http://www.huffingtonpost.com/2012/12/05/sandy-cleanup-workers_n_2245717.html.

¹³⁵ Ibid.

¹³⁶ Delp, Podolsky, and Aguilar, “Risk amid Recovery,” 485

¹³⁷ Ibid.

¹³⁸ Pearson and Weinstock, “Minimizing Safety and Health Impacts at Disaster Sites,” 5.

often overwhelming training session.¹³⁹ Multiple studies have shown that a more comprehensive disaster-response training program is needed among all responders, including first responders and skilled support personnel.¹⁴⁰

E. MEDICAL SURVEILLANCE AND HAZARD IDENTIFICATION

Early detection, intervention, and treatment of illness (both physical and mental) are paramount in responders and have been identified as needed action since at least the WTC response.¹⁴¹ However, past disaster responses have failed to address surveillance or tracking of responder exposure or injury. Following the WTC attack, it took almost seven weeks to establish a health and safety plan, and it was not until 2002, at least three months after the recovery started, that the WTC Worker and Volunteer Medical Screening Program commenced.¹⁴²

The Worker Safety and Health Support Annex does require some limited medical surveillance. However, it only mandates monitoring when it is otherwise required by regulation (e.g., in environments with known asbestos and lead), and fails to provide a requirement for long-term epidemiological follow-up, instead only recommending an evaluation of the possibility.¹⁴³ It is unclear why many of these provisions have not yet been fully implemented, but, as was identified during Hurricane Katrina, funding and responsibility appear to have a major impact.¹⁴⁴ Additionally, the annex applies specifically to disasters, and the sporadic nature of funding for disaster response may prevent the establishment of procedures or systems to facilitate efficient medical surveillance during a disaster.

¹³⁹ Newman, "Protecting Worker and Public Health during Responses," 1292.

¹⁴⁰ Ibid., 1292; Delp, Podolsky, and Aguilar, "Risk amid Recovery," 586; Pearson and Weinstock, "Minimizing Safety and Health Impacts at Disaster Sites," 5; David M. Newman, "Protecting Disaster Responder Health; Lessons (Not Yet?) Learned," *New Solutions* 21, no. 4 (2011): 586.

¹⁴¹ Bascetta, *September 11*.

¹⁴² Newman, "Protecting Worker and Public Health during Responses," 1287; Perritt et al., "Work-Related Injuries and Illnesses," 2.

¹⁴³ "Worker Safety and Health Support Annex," FEMA, WSH-5.

¹⁴⁴ GAO, *Disaster Preparedness*.

V. FINDINGS AND RECOMMENDATIONS

A review of occupational injury data from various disasters supports an increased injury rate among responders in all types of disasters studied. However, there is insufficient data to support a statistical sample across all events and occupations to prove causation; further study should be considered in this area. Nevertheless, given the analysis of past disasters and the apparent connection between injury rates and disasters, the following recommendations are made to reduce injury rates among responders:

A. IMPROVED DATA COLLECTION

First, this study has revealed that there is insufficient data collection on responder injury and illness during disasters to adequately conduct a root cause analysis and a comparison with existing policies. Only broad recommendations can be made based on a limited number of case studies. There is a need for increased data collection from the initial onset of disasters through long-term effects to provide a thorough set of baseline data for future research. Greater attention must also be placed on medical surveillance for responders in a disaster. Tracking and monitoring both risk and injury has been lackluster in every event studied for this research, except the Deepwater Horizon oil spill.

The best way to identify efficient means for improving injury rates is through specific targeted actions. Additional data collection and monitoring can allow future researchers to identify specific circumstances that increase risk, and work to develop either better practices or better protective devices for responders. However, without specific data, policymakers must continue to rely on general understanding and recommendations, which may not target the true nature of the problem.

There are definite challenges to improved data collection, the greatest of which are authority and funding. While the Worker Safety and Health Support Annex does call for these items, there is no clear source for funding outside a disaster, nor a clear responsibility within a federal agency to maintain these systems. Consider the World Trade Center Health Program, which performs many of these tasks on a very limited scale; this

organization has faced repeated funding issues, and has often been a topic of media discussion when part or all of the program is defunded in the federal budget.¹⁴⁵ A program for all disasters is likely to face similar funding issues, and may not have the political force that WTC-related measures often carry in Congress.

B. ENFORCEMENT OF EXISTING POLICIES

This study has also revealed a need for increased enforcement of existing policies at all levels, especially relating to the use of PPE. The research demonstrated that PPE was paramount to workers' ability to efficiently and safely respond to disasters; however, it also showed that its use was often overlooked or ignored.¹⁴⁶ During all the events studied in this research, there were numerous examples of noncompliance with PPE rules and best practices. While in some cases a lack of compliance was initially caused by limited access to PPE, the compliance rates did not substantially improve after PPE was made available.

OSHA's technical assistance approach, when used in place of enforcement, has been ineffective. While there is certainly always benefit in collaboration, enforcement should be a priority. Safety standards should not be suspended or loosely enforced. Both regulatory agencies and responders' immediate supervisors need to ensure compliance with safety procedures and take enforcement actions when procedures are not followed.

Additionally, it was shown that PPE can be uncomfortable or inconvenient in physically demanding conditions, such as with respirators during the WTC response.¹⁴⁷ While proper supervision and regulatory enforcement can increase

¹⁴⁵ Michael McAuliff, "President Barack Obama Budget Office Cuts Funds for 9/11 Health Studies on WTC Rescue Workers," *New York Daily News*, May 18, 2010, <http://www.nydailynews.com/new-york/president-barack-obama-budget-office-cuts-funds-9-11-health-studies-wtc-rescue-workers-article-1.446275>; Michael McAuliff, "Why Jon Stewart Fought so Hard for 9/11 Responders," *Huffington Post*, December 23, 2015, http://www.huffingtonpost.com/entry/jon-stewart-sept-11-responders_us_567ab1e5e4b06fa6887f7bd8; Michael McAuliff, "Congress Finally Passes a 9/11 Health Bill," *Huffington Post*, December 18, 2015, http://www.huffingtonpost.com/entry/911-bill-passes-congress_us_56742074e4b014efe0d51b50.

¹⁴⁶ Pearson and Weinstock, "Minimizing Safety and Health Impacts at Disaster Sites."

¹⁴⁷ Bascetta, *September 11*.

compliance and reduce injury, additional research in this area could lead to more effective and less restrictive equipment for use.

Enforcement of existing policies appears to be one of the easiest recommendations. While it is possible that it will result in some initial resistance from responders or agencies not used to the enforcement, the legal framework and funding is already in place.

C. IMPROVED RISK SURVEILLANCE

Response agencies should know where their resources and risks are. Gathering hazard information and resource locations prior to initial physical access to the site can reduce risk to responders by allowing agencies to better prepare for initial deployments.

A review of the data available at the time of the WTC attack revealed that, had agencies accessed the Toxic Release Inventory during the initial onset of the disaster, agencies would have been aware of the presence of tetrachloroethylene, PCBs, arsenic, and other toxic raw materials, and therefore been able to better prepare responders for the risks.¹⁴⁸ In the future, data on facilities and locations that might present safety and health risks for responders in a disaster will be key in administering a safety management program.

Proper monitoring of risk is essential in identifying and choosing proper methods for reducing injury, whether through engineering controls or PPE. Without adequate surveillance of injuries, it is impossible to identify causation of repetitive injuries in a disaster, or to make the data available for further study.

Improved risk surveillance may run into some of the same funding issues as medical surveillance. Funding and systems need to be put in place to track the data. However, unlike medical surveillance, the level of skill and the number of people that need to be involved are sustainably lower. Improved risk surveillance relies on central

¹⁴⁸ Newman, "Protecting Disaster Responder Health," 573–590.

reporting of high-risk possibilities, such as high-risk chemical stores, which many localities already track.

D. PROPER STAFFING

Response organizations must ensure that adequate personnel are deployed to an event to accomplish the response and recovery objectives without sacrificing responder rest time. The research demonstrated that responders are often expected to work extended hours in high pace-environments, and as a result have inadequate periods of rest that lead increased risk of injury and decreased efficiency.¹⁴⁹

In events where existing personnel are likely to be insufficient to meet response or recovery objectives, it is imperative to coordinate with partner organizations to ensure that adequate personnel are sent to mutual aid efforts. Many response organizations already have mutual aid agreements or memorandum of understanding with other organizations to provide assistance when needed.

There may be some impediments to implementation associated with cost. However, some of the financial implications will be countered by a reduction of overtime that must be paid to responders. In large events, there may also be difficulties with staffing availability in the local area; the associated travel time may require a short period of inadequate staffing while waiting for additional resources.

E. IMPROVED TRAINING FOR SKILLED SUPPORT PERSONNEL

Lastly, in order to effectively respond during a disaster, agencies must address issues concerning safety equipment and bolster both on-site training and pre-incident training for responders.¹⁵⁰ Past events have shown that just-in-time training should not be used in place of training before an incident, and doing so may leave workers inadequately prepared to respond. Training should not only cover worker safety but

¹⁴⁹ Rusiecki et al., “Disaster-Related Exposures and Health Effects,” 820, 830.

¹⁵⁰ Pearson and Weinstock, “Minimizing Safety and Health Impacts at Disaster Sites.”

also worker rights to safety, so that responder know when to speak up regarding safety issues that could endanger their, or their coworkers', well-being.¹⁵¹

First response agencies already provide this training to their employees; however, the same is not necessarily true for skilled support personnel.¹⁵² Responders should be coached in various requirements before deploying to a disaster area. Most importantly, there should be minimum standards for training all responders before they are deployed to a disaster response operation. Such training should ensure that common terminology is used for safety and health issues as well as the relevant protective equipment and decontamination and rehabilitation processes.

The primary limitation for increased training, as with many of the other recommendations, is funding. In order to institute additional pre-disaster training, staff time and resources must be diverted from other efforts. However, there are existing sources for local responders to find funding for training, such as FEMA's Homeland Security National Training Program and Continuing Training Grants, among other grant programs.¹⁵³

¹⁵¹ Newman, "Protecting Disaster Responder Health."

¹⁵² Pearson and Weinstock, "Minimizing Safety and Health Impacts at Disaster Sites."

¹⁵³ "Continuing Training Grants," FEMA, last updated August 11, 2016, <https://www.fema.gov/continuing-training-grants>.

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